NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING - FLEXIBLE MEMBRANE
(no.)
CODE 521A

DEFINITION

A manufactured hydraulic barrier consisting of a functionally continuous sheet of synthetic or partially synthetic, flexible material.

PURPOSE

To control seepage from water and waste impoundments for water conservation and environmental protection.

CONDITION WHERE PRACTICE APPLIES

On ponds and water storage structures that require treatment to control seepage rates within acceptable limits.

On waste storage and waste treatment facilities built in or of excavated earth, and which require treatment to prevent the migration of contaminants from the site.

CRITERIA

Structures to be lined shall have been constructed to meet all applicable NRCS standards. All inlets, outlets, ramps, and other appurtenances may be installed before, during, or after the liner placement, but shall be done in a manner that does not damage or impair the proper operation of the liner.

All flexible membranes shall be certified by the manufacturer to be suitable for the intended use.

Design of the flexible membrane shall be in accordance with manufacturer recommendations. All flexible membrane installations shall meet the material and installation requirements of the plans and specifications provided for each installation, and shall be certified by the installer.

Minimum Criteria for Membranes

Type	Limiting Parameter
HDPE	40 mil thickness
LLDPE	40 mil thickness
PVC	30 mil thickness
GCL	0.75 lb./sq ft (bentonite)
EPDM	45 mil thickness

HDPE = High Density Polyethylene
LLDPE = Linear Low Density Polyethylene
PVC = Polyvinyl Chloride
GCL = Geosynthetic Clay Liner
EPDM = Synthetic Rubber

Select soil materials shall be used as cover for liners where required for the proper performance, protection, and durability of the installation. Cover soils shall not contain sharp, angular stones or any objects that could damage the liner. Maximum allowable particle size of soil cover material shall be 3/8-in (10 mm), unless the liner is cushioned by a needle punched, non-woven geotextile. Cover materials shall be stable under all operational and exposure conditions.

Subgrade preparation shall conform to manufacturer recommendations. Subgrade materials shall not contain sharp, angular stones or any objects that could damage the liner or adversely impact its function.

All structures shall be fenced to protect the liner from damage and for the safety of humans,

livestock, wildlife, and pets.

Manufacturer recommendations shall be followed with regard to protection from weather and exposure.

If venting is used, manufacturer recommendations shall be followed regarding vent type and spacing.

CONSIDERATIONS

Venting should be considered if gas build up under the liner is anticipated.

If high water tables could adversely affect the proper functioning of the facility, interceptor or relief type drainage systems should be considered to control uplift pressures.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for specific field sites in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended uses.

OPERATION AND MAINTENANCE

A plan for operation and maintenance of the liner shall be prepared.

Construction Specifications

POND SEALING OR LINING, FLEXIBLE MEMBRANE

1. SCOPE

Work shall consist of the furnishing and installing all flexible membrane, filter, and cover material in accordance with the lines and grades shown on the plans. Location of the flexible membrane shall be as shown on the drawings or as staked in the field.

2. INSTALLATION

a. **Subgrade preparation**. The area to be lined shall be drained and allowed to dry until the surface is firm and can support the personnel and equipment that must travel over it during installation of the lining. All banks and fills in the area to be lined must be sloped no steeper than 1 horizontal to 1 vertical for exposed linings and 2 1/2 to 1 for buried linings. The foundation area for flexible membrane linings shall be smooth and free of projections that can damage the lining. Stumps and roots shall be removed. Rocks, hard clods, and other such material shall be removed, rolled so as to provide a smooth surface, or covered with a cushion of fine soil. If needed, an effective sterilant shall be applied to the subgrade at the rate recommended by the manufacturer. An anchor trench shall be excavated completely around the area to be lined at the planned elevation of the top of the lining. The trench shall be 8 to 10 inches (200 to 250 mm) deep and about 12 inches (300 mm) wide. All lining material shall be free of damage or defect. Each package delivered to the job site shall bear the name of the material, the manufacturer's name or symbol, the quantity therein, and the thickness or weight of the material.

b. **Placement**. Membranes shall be loosely spread over the subgrade. Polyethylene film requires about 5 percent slack for satisfactory results. All field splices shall be made according to the manufacturer's recommended technique, using materials furnished for this purpose. The joints shall be watertight and capable of maintaining their integrity throughout the expected life of the lining. Approximately 30 inches (760 mm) of the top of the lining shall be placed in the anchor trench and anchored with compacted backfill. For covered mem

branes, the material to be used as a protective cover shall be free of large clods, sharp rocks, sticks, and other objects that can puncture the lining. The cover shall be placed to the specified depth without damage to the membrane.

c. **Materials.** All materials are to meet the requirements indicated in Tables 1, 2, 3, 4, 5, 6, 7, 8, and 9 as appropriate.

Table 1. Requirements for polyethylene and ethylene co-polymer plastic film.

Test Description		Requirements: Type I Polyethylene	Requirements: Type II Co-polymer	Test Method
Tensile strength, each direction, minimum average	lb/in 2	1,800	2,000	ASTM-D-882,Method "A"
Ultimate elongation, each minimum average	pct	500	500	ASTM-D-882, Method "A"
Impact resistance, minimum average	g/mil	45	65	ASTM-D-1709, Method "B"
Water vapor permeability	perm-mil	0.7	1.5	ASTM-E-96
Tear resistance, each direction, minimum	g/mil	80	80	ASTM-D-1922
Soil burial	pct	5	5	ASTM-D-3083
Tensile strength change, each direction, maximum				
Elongation loss, each direction, maximum	pct	20	20	
Lumionous transmittance, maximum	pct	1.0	1.0	National Bureau of Standards Publication PS-17

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Table 2. Requirements for reinforced rubber sheeting

Test Description		Requirements		Test Method
		Up to 20 mil thick	20 mil thick and greater	
Breaking strength, minimum				ASTM-D-751
Warp direction	lb/in	75	100	
Fill direction	lb/in	75	100	
Ultimate elongation, each				ASTM-D-751
Warp direction	pct	30	30	
Ozone resistance,				
Procedure "B"	days	7	7	ASTM-D-1149 and
50pphm, 100°F				ASTM-D-518
Hydrostatic strength retained	pct	100	100	Federal Spec.
after ozone exposure, 7				CCC 191b
days (Mullen)				Method 5512
				ASTM-D-518
Heat aging, 7 days at 212°F				ASTM-D-573
Tensile strength retained	pct	90	90	
Elongation retained	pct	90	90	
Tear resistance, minimum,				ASTM-D-751
Warp or fill direction	lb	8	8	(tongue)
Hydrostatic burst (Mullen, Minimum	lb/in 2	100	175	ASTM-D-751(1)
Dimensional stability, 7 days at 212°F				
Change in length or width	pct	±1.0	±1.0	
Low-temperature flexibility (optional)				Federal Specification
No cracking or flaking		-40°F	-40°F	CCC 191b Method 5874
Commercial field splice				Commercial field
Strength Shear force, minimum	pct	75	75	splice 1 in. wide strip, pulled in shear at 10in./min, after 7 days cure at room temperature

[1] A 1-ft [2] sample. 10 in. bench marks in warp and fill direction, placed on aluminum or stainless plate in changing air over.

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Table 3. Requirements for reinforced rubber sheeting.

Test Description		Requirements		Test Method
		Type I Polyethylene	Type II Co-polymer	
Tensile Strength, minimum	lb/in_2	1,200	1,200	ASTM-D-412
Modulus at 300% elongation, minimum	lb/in_2	600	600	ASTM-D-412
Ultimate elongation,	pct			ASTM-D-412
Shore "A" hardness		60 + 10	60 + 10	ASTM-D-2240
Ozone resistance, Procedure "A"	pct			
No cracks, 50 pphm at 100°F, 20% elongation	days	7	-	ASTM-D-518
No cracks, 100 pphm at 100°F, 50% elongation	days			ASTM-D-518
Heat again, 7 days at 212°F,				
Tensile strength retained	pct	75	75	
Elongation retained	pct	75	75	
Water vapor permeability at 80°F, maximum	perm mil	0.002	0.05	ASTM-F-96 (procedure BW)
Tear resistance, minimum	lb/in_2	150	150	ASTM-D-624 Die "B"
Dimensional stability, 7 days at 212°F				
Change in length or width	pct	+0.5	+0.5	
Commercial field Strength 60 shear force, Minimum tensile	pct	60	60	Commercial Field Splice 1 in. wide strip, pulled in shear at 10 in./min, after 7 days cure at room temperature

NOTE: Type "A" sheeting is recommended for general-purpose outdoor use. Type "B" material is recommended for use if an extreme outdoor environment requires a highly weatherable lining.

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Table 4. Requirements of polyvinyl chloride plastic sheeting.

Test Description		Requirements	Test Method
Tensile Strength, each direction, minimum average	lb./in 2	2,000	ASTM-D-882
Elongation at break, minimum	pct	250	ASTM-D-882, Method A
Tear resistance, each direction, minimum	g/mil	160	ASTM-D-1922
Resistance to soil burial (percent change maximum in original value)	pct	-5	ASTM-D-3083 (120-day soil burial)
Breaking factor	pct	-20	
Elongation at break	pct	±10	
Modulus at 100% elongation			
Bonded seam strength, percent breaking factor	pct	80	ASTM-D-3083 Para.9.3 (1-in width)

Table 5. Unreinforced chlorsulfonated polyethylene.

Test Description		Minimum Requirements	Test Method
Tensile strength, minimum pounds per square inch	pct	1,000	ASTM-D-412
Ultimate elongation, minimum	pct	250	ASTM-D-412
Ozone resistance, 50 pphm, 20% strain, 100°F, 8,000 hr.	pct	+0	ASTM-D-1149
Heat aging, 14 days at 212°F			ASTM-D-412
Tensile strength, minimum pounds per square inch	pct	1000	
Elongation at break	pct	150	
Tear resistance, minimum	lb./in	250	ASTM-D-624 Die B
Commercial field splice Strength, shear force, minimum tensile	pct	60	ASTM-D-882, Method A 7 days cure
Weight change after 7 days at 70°C in water, maximum	pct	5	ASTM-D-471

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Table 6. Reinforced chlorsulfonated polyethylene.

Test Description	Minimum Requirements 30 mils thick and greater		Test Method
Breaking strength, minimum			ASTM-D751
Rubber	lb/in	100	
Fabric	lb/in	75	
Ultimate elongation, maximum			ASTM-D-751
Rubber	pct	150	
Fabric	pct	20	
Ozone resistance, 50 pphm, 20% strain, 100°F, 8,000 hr.	pct	+0	ASTM-D-1149
Hydrostatic strength after ozone exposure, 7 days (Mullen), percent retained	pct	100	Fed. Spec. CCC 191b ASTM-D-5512 ASTM-D-518
Heat aging, 14 days at 212°F of Original			ASTM-D-412
Tensile strength	pct	90	
Elongation percent retained of original	pct	90	
Tear resistance, minimum			ASTM-D-751
Warp or fill direction	pct	10	(Tongue)
Puncture resistance, pounds minimum	pct	120	FTMS 101B, Method 2031
Commercial field splice			ASTM-D-882
Strength, shear force, percent of minimum break	pct	75	7 days cure

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Table 7. Requirements for high density polyethylene (HDPE).

Test Method	Requirements 80 mils	Method 100 mils	Test Method
Minimum tensile properties (each direction)			ASTM-D-638
Tensile strength yield (pounds/inch width)	120	150	
Tensile strength at break (pounds/inch width)	120	150	
Elongation at yield (percent)	10	10	
Elongation at break (percent)	500	500	
Modulus of elasticity (pounds/sq. in.)	80 ,000	80,000	
	40	40	ASTM-D-1004
Tear resistance (pounds, minimum)			
Low temperature	-40°F	-40°F	ASTM-D-746
Dimensional stability (each direction, percent change, maximum)	+3	+3	ASTM-D-1024 212°F, 15 min.
Resistance to soil burial 1 (percent change maximum in original value			ASTM-D-3083 (120-day soil burial)
Tensile strength yield	+10	+10	
Tensile strength at break	+10	+10	
Elongation at yield	+10	10	
Elongation at break	+10	+10	
Modulus of elasticity	+10	+10	
Bonded seam strength [2] (factory seam, breaking factor, pounds/inch width)	108	135	ASTM-D-3038
Environmental stress crack (minimum, hours)	500	500	ASTM-D-1693

[1] Test value of "after exposure" sample is based on precut sample dimensions; 120-day test is 120-day test is required for initial certification.

[2] Factory bonded seam strength is the responsibility of the fabricator.

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Table 8. Requirements for supported extended polyurethane.

Property	Test Method	Supported finished material[2] Type 1	Type 2	Type 3	Type 4
Thickness	ASTM-D-751				
Overall (mils, minimum)		25	45	L30	70
Minimum Tensile Properties	ASTM-D-751				
Breaking Strength-fabric TD		50	70	110	100
(pounds, minimum)		70	120	120	140
Breaking Strength-Composites	MD	90	160	130	220
	TD	75	160	130	160
Tear Strength (pounds minimum)	ASTM=D=751	75	160	130	160
composite	Tongue Method 8 x 8-in sample				
Initial		2.5	4.5	35	4.5
After Heat Aging	212°F, 30 days	2.5	4.5	35	4.5
Low Temperature Composite	ASTM-D-2136	-40°F	-40°F	-40°F	-40°F
	1/8 in mandrel, 4hr Pass				
Unsupported sheet, 100 mils			Below –60°F		
Dimensional Stability	ASTM-D-1204				
(each direction percentage change maximum)	212°F, 1 hr	-0.8	-0.5	-1.3	-0.7
Resistance to Soil Burial [1]	ASTM-D-3083				
(percent change maximum in original values)	365-day soil burial 30-mil sheet (as modified in Appendix A)				
Unsupported sheet	ASTM-D-822				
Breaking Factor					+15
Elongation at Break					-15
Initial Modulus					+30
Membrane Fabric Breaking Factor	ASTM-D-751	TBD	TBD	TBD	TBD
Bonded Seam Strength	ASTM-D-751				
(pounds, minimum)	(As modified in Appendix A. 12 in/min)		greater than single layer		
Hydrostatic Resistance	ASTM-D-751				
(pounds per square inch, minimum)	Method A, Procedure I	80	210	250	280
Ozone Resistance	ASTM-D-1149			NA	
	(As modified in 7 days, 100 pphm 104°F, 1/8 in bent loop)				
Ply Adhesion (each direction pounds/in. width minimum)	ASTM-D-413 Machine Method Type A			NA	
Volatile Loss, percent (unsupported)	ASTM-D-1203 Method A 30-mil sheet			0.4	
(Puncture Resistance, pounds)	FTMS 101B, (Method 2065)	25	50	45	70

[1] Test value of "after exposure" sample is based on precut sample dimensions; 120-day test is required for initial certification.

[2] Supporting Fabrics:

Type 1: Nylon 6.6 2.0 oz/ya $_2$

Type 2: Polypropylene 3.1 oz/ya $_2$

Type 3: Composite of 2 layers 0.5 oz/ya $_2$ nylon 6.6 plus 5 x 5 1000d polyester scrim (4.1 oz/ya $_2$ total)

Table 9. Requirements for reinforced ethylene interpolymer alloy.

Test Description	Requirements	Test Method
Thickness, mils minimum		ASTM-D-751
Overall	27	
Breaking Strength, lb. min.	400	ASTM-D-751 Method A
Tear Strength, lb. min.		ASTM-D751
Initial	125	Tongue Method
After aging	75	8 x 8 sample
Low Temperature	-30°	ASTM-D-2136 1/8 in. mandrel 4 hr. pass
Dimensional Stability (each direction % change max.)	2	ASTM-D-1204 212f, 1hr
Resistance to Soil Burial (percent change maximum in original values)		ASTM-D-751 Method A
Membrane Fabric Breaking Strength	25	
Hydrostatic Resistance (lb. /sq. in., min.)	500	ASTM-D-751 Method A, Procedure 1
Ozone Resistance		ASTM-D-1149 (7 day, 100 pphm 104°F, 1/8 in. bent loop)
Ply Adhesion (each direction lb./in. width min.)	Film Tear Bond or 8 lb. per in.	ASTM-D-413 Machine Method Type A

3. FENCING

The area covered by a flexible membrane shall be fenced if livestock may be present to protect the membrane from possible puncture.

4. VEGETATION

The finished area shall be shaped and smoothed and all disturbed areas vegetated to protect against erosion. Mowing and maintenance activities shall be careful to avoid cutting or damaging the flexible membrane.